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Comments on S&T Block 2 Items

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Position: I am opposed to the proposed changes contained in Block 2 of the S&T Committee agenda. There are no problems with the requirements of H44 or OIML R76, on which the accuracy classes and tolerances for scales are based. **All of the items contained in Block 2 should be withdrawn.**

The proposal in Item SCL-20.8 to increase the resolution of a scale to reduce rounding errors conflicts with the very principles that form the basis of accuracy classes and the associated tolerances. Very little is accomplished if you increase the resolution of a scale by ten times to reduce rounding error if the tolerance, i.e., the inaccuracy of the scale, is ten times greater in terms of the scale division, d. If there is a problem that the scale division (e = d) is too large for the application, then a suitable scale with an appropriate resolution and accuracy should be required under G-UR.1.1. The proposal to increase resolution without increasing the required accuracy of the scale used in the application is both ill-advised and inadequate. Please see the discussion below under the heading "*Why the Scale Tolerance Structure Was Changed in 1984*."

Discussion:

These comments address the major problems with the proposed changes in the items in Block 2. The lesser issues are not discussed but can be addressed if more information is needed.

Suitability of Equipment

Accuracy classes for scales were established in OIML R76 and adopted into Handbook 44 to establish relationships between accuracy classes, the number of divisions within each accuracy class, and the sizes of scale divisions within each accuracy class. Briefly stated, (a) the higher the accuracy class, the greater the accuracy of the scale; (b) the more divisions a scale has for a given accuracy class, the more accurate the scale has to be (Class III L is the exception to this rule); and (c) with a given accuracy class, the scale with a smaller scale division is more accurate than scales of the same accuracy class with the same number of divisions, but with larger scale divisions.

The use of scales with "large" scale divisions to weigh small quantities of a "high-priced" commodity in the cannabis trade is an issue of suitability of equipment. However, the proposal to allow d < e is the wrong solution. If a verification scale division, e = 0.1 g (which, for Class I and II scales used in direct sale applications, must be equal to d) is considered to be too large for the application, then increasing the resolution of the scale division, d, is not sufficient; rather, a scale with a smaller weight value for e, namely, e = 0.01 g, should be required, **so that both the accuracy and resolution for the transaction are increased.** There is limited benefit to increasing resolution by allowing d < e as Ross proposes, since the maintenance tolerance (i.e., the accuracy requirement) that applies to a given load would be at least 10 d.

Handbook 44, General Code, G-UR.1.1. states:

> "**G-UR.1.1. Suitability of Equipment.** – Commercial equipment shall be suitable for the service in which it is used with respect to elements of its design, including … the value of its smallest unit and unit prices."

The Scales Code, with respect to accuracy classes states:

> "**UR.1. Selection Requirements.** – Equipment shall be suitable for the service in which it is used with respect to elements of its design, including but not limited to, its capacity, number of scale divisions, value of the scale division or verification scale division, minimum capacity, and computing capability."

If weights and measures officials conclude that a verification scale division of e = 0.1 g is too large for the cannabis trade, then they should require that scales with smaller (verification) scale divisions, e.g., e = 0.01 g, be used. Handbook 44 should NOT be changed to improperly address a suitability of equipment issue.

One primary objective for adopting accuracy classes in the Scales Code was to eliminate the practice of designing scales with lots of scale divisions, d, that were not related to the accuracy of the scales. Now the proposals in Block 2 would allow the very practice the adoption of accuracy classes was intended to eliminate.

The Erroneous Justification for More Scale Divisions

To understand why this is the case, you have to understand two things:

1. Why the tolerance structure for scales was changed in 1984; and
2. The graduated scale on neck-type volume standards is to provide adequate resolution to properly apply the tolerance in the test of liquid meters.

Why the Scale Tolerance Structure Was Changed in 1984

Prior to 1984, most of the scale tolerances were specified as a percent of the test load for test loads or 1000 lb or more and as fixed tolerance values for test loads less than 1000 lb. The problem at the time was that some sales representatives would mislead potential purchasers of scales by saying that the purchaser of a scale would have more accurate scale if they purchased a scale with a smaller scale division. Basically, the claim was that if the purchaser bought a scale with more scale divisions, then the more accurate the scale would be. This claim was false, because the tolerance was either a fixed value for a give test load or a fixed percentage of the test load.

The scale tolerances were changed (1) to agree with the tolerances in OIML R76 (except for Class III L, but the maximum number of divisions was limited to 10 000) and (2) to establish a relationship between the accuracy classes, number of divisions and the accuracy of the scales. The revised tolerances eliminated the problem of sales representatives promoting scales with smaller scale divisions as being more accurate than scales with larger scale divisions, because under the revised tolerances, a relationship between accuracy classes, the number of scale divisions and the size of the scale divisions was established.

Ross' proposals would negate this critical benefit of the revised scale tolerances.

The Graduated Scale on Neck-Type Volume Standards

In most cases, the tolerances for liquid meters are still percentages of the measured and indicated quantity. There was not a problem in petroleum industry in 1984 and is not today of promoting more divisions as more accurate meters, in part, because the measurement process involves summing many small increments of measured volume into the total volumes delivered in transactions.

Ross makes the claim that the graduated scale on a volume standard is the "verification scale" [division] for retail motor-fuel dispensers. This is incorrect.

The graduated intervals on the scale of a prover must have adequate resolution to provide a valid assessment of the error in the meter delivery relative to the tolerance for the measuring device, which corresponds to the overregistration or underregistration of the meter indication. The required resolution for the graduated scale on the volume standard is stated in NIST Handbook 105 series for volume field standards. In OIML R 120, this requirement is stated as:

> 2.3.2 Standard test measures
> The diameter of the neck of the standard test measure shall be large enough to avoid problems with regard to the trapping of liquid or air or vapor or to the cleaning of the measure, and small enough so that the sensitivity in detecting changes in the level in the measure is sufficient for achieving the measurement accuracy required in 2.2. It is assumed that the requirement will be met if a difference of at least 3 mm in the liquid level in the neck is equivalent to the absolute value of the maximum permissible error of the standard capacity measure.
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> 2.2.2.2 For standard test measures and proving tanks, the maximum permissible errors shall be ± 1/2 000 of the nominal capacity.

The tolerance for the volume standard is 0.05 %. This is to ensure that the standard is sufficiently accurate to be used to test the **accuracy** of meters covered by OIML R117. The smallest tolerance for metering systems (measuring systems) in Table 2 of R117 is 0.2 %, which applies to meters of accuracy class 0.3 during type evaluation and verification of the meter before the initial verification of the measuring system. The required volume graduations on the neck of the volume standard are to ensure adequate **resolution** to read measurement errors relative to the tolerance. **The graduations on the volume standard are not the "verification scale" for the meter and they are not analogous to the verification scale division for scales.**

The discussion of "verification scale" beginning on page S&T-125, line 40, is invalid. Retail motor-fuel dispensers indicate to 0.001 gal because the petroleum industry wants dispensers to be able to indicate every whole dollar amount for fuel deliveries. Handbook 44 only requires indications to 0.01 gal.[1] However, when unit prices reach a certain level, for example, $3.00 per gallon, not every whole dollar amount can be indicated as a money value. Consider the scale in the delicatessen of a supermarket. A deli computing scale usually has d = 0.01 lb. It cannot compute whole dollar amounts for many unit prices for products weighed on the scale. This is not a problem from a regulatory perspective, as long as there is mathematical agreement among the weight, unit price and total price indications.

The Differentiated Scale Division on Class I and Class II Scales

On page S&T-126, line 19, Ross asked the question, "Why does the Code require d to be differentiated when d is smaller than e?" This differentiated scale division for Class I and Class II scales is required in OIML R76 and was carried over into the Scales Code. The reason this is required is to alert both the user and a potential customer for products weighed on these scales that the differentiated scale division is not considered "accurate" to the value of d, since tolerance calculations are based upon the verification scale division, e. OIML R76 covers laboratory balances as well as commercial weighing instruments. Laboratory balances are often used in comparison calibrations of one standard to another. In laboratory weighing designs that measure the small differences between one mass standard and another by comparison methods, the value of d has significance with respect to the standard deviation (and ultimately the uncertainty statement) for high precision mass calibrations. In comparison mass calibrations used to measure small differences in mass, balance readings to the value of d may be significant, but the accuracy of the balance to e is not a significant issue.

This requirement for a differentiated scale division was included in the Scales Code in the event that Class I and II scales would be used commercially in the United States.

[1] NIST Handbook 44, 2020 Edition, Liquid-Measuring Devices Code, "**S.1.6.5.2. Money-Value Divisions, Digital.** – A computing type device with digital indications shall comply with the requirements of paragraph G.S.5.5. Money-Values, Mathematical Agreement, and the total price computation shall be based on quantities not exceeding 0.05 L for devices indicating in metric units and 0.01 gal intervals for devices indicating in U.S. customary units."